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NATIONAL RESEARCH COUNCIL

REPORT

ON

INQUIRY IN EUROPE

REGARDING

The Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat

BY

R. NEWTON

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1930

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LETTER OF TRANSMISSAL TO THE CHAIRMAN OF THE SUB-COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

Hon. JAMES MALCOLM,
Chairman, Sub-Committee of the Privy Council on
Scientific and Industrial Research,
Ottawa, Canada.

SIR,—I have the honour to present herewith a report on an inquiry in Europe regarding the feasibility of using protein content as a factor in grading and marketing Canadian wheat.

This report has been prepared for the National Research Council by Dr. Robert Newton, Professor of Field Crops and Plant Biochemistry at the University of Alberta, and Acting Director of the Division of Economic Biology of the National Research Council, who was sent to Europe for the purpose of carrying out the inquiry in accordance with the instructions contained in Recommendation No. 9 of the Fourth Report of the Select Standing Committee on Agriculture and Colonization, presented to, and approved by the House of Commons at the Session of 1929, which reads as follows:—

> "Your committee submits the following recommendations on the subject of the protein content of wheat:—
>
> "That pursuant to a request embodied in the report of the 1928 Select Standing Committee on Agriculture and Colonization, the National Research Council made an exhaustive survey of the United States system of paying premiums for high protein wheat and reflecting the same back to the grower and reported thereon to the minister.
>
> "That your committee considers this report a very valuable contribution to available data on the protein question and recommends that the National Research Council be requested to adopt such measures as it seems best fitted to bring this report to the attention of, and make it available to interested persons.
>
> "That the said report of the National Research Council having suggested further investigation of the export demand for high protein wheat in the major importing countries and your committee concurring in this view recommend that the National Research Council be requested to conduct a personal survey of the major European markets and report to the minister before next session of Parliament."

Faithfully yours,

(Sgd.) H. M. TORY,
President, National Research Council.

OTTAWA, March 7, 1930.

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Report on Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat

By R. Newton

SUMMARY

1. The investigation of protein content as a factor in grading and marketing wheat, discussed in relation to American and Canadian conditions in an Interim Report presented March 15, 1929, is now reported in relation to the conditions of the European export market.

2. Since the presentation of the Interim Report, additional experimental evidence has been accumulated, which confirms the conclusion that the protein content of sound well-ripened wheat of a single type, as in the Manitoba Northern grades, is a good indication of its baking strength and value for blending with weaker wheats.

3. European milling chemists in general make physical rather than chemical tests of flour quality, and discount the value of the protein test because it indicates quantity rather than quality.

4. English millers mill only blended wheats. They regard protein content as but one of several factors which they must take into account, and are not disposed to single it out for special consideration in buying their wheat. The British public prefers a type of loaf made from a weaker blend of flour than is popular in Canada and the United States, and changes in baking methods are tending to reduce still further the proportions of Manitoba wheat used. The National Association of British and Irish Millers have recorded their official opinion that, " a guarantee of protein content in the standard grades would present difficulties without compensating advantages." Merchants also objected because of trade difficulties.

5. Scottish millers mill a high proportion of straight Manitoba flour, suited to the baking processes of that country, but felt they could not use protein to advantage as a factor in purchasing their wheat.

6. Irish millers mill some straight Manitoba wheat, and use it also in blends, but doubted that there was any demand for high protein wheat, such as might lead to the bidding of premiums.

7. In Norway the wheat-milling industry is a state monopoly. A high proportion of Manitoba wheat is used, but the demand is for average wheat, not segregated by protein content.

8. In France, Germany and Italy, the high import duties assessed on a bushelage basis have led to a preference for high-grade wheat, and millers in these countries took more interest in protein grading. However, their interest was in high-protein lots, and they would have no market for low-protein lots. Again, merchants objected to the trade complications, and chemists to the validity of the chemical tests. Germany gave the protein grading proposal the best reception of any country. The proportion of Canadian wheat going to Great Britain, however, is so large that the British attitude must be given most weight.

9. There seems to be at present no practical way in which protein content can be used effectively in the marketing of Canadian wheat in Europe.

10. Constancy of grade qualities seems to be the outstanding requirement of the European trade.

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INTRODUCTION

An Interim Report on Protein Content as a Factor in Grading Wheat, prepared in accordance with a reference from the House of Commons to the National Research Council and the Board of Grain Commissioners, was presented on March 15, 1929, and published as Bulletin No. 13 of the National Research Council of Canada. This report covered an investigation of the working out of protein testing in the United States, and certain related questions, and discussed the possible applicability of protein testing to Canadian conditions. Some serious difficulties were pointed out, the most important of which grew out of the fact that the bulk of the Canadian wheat crop is exported, and such efforts as have been made in the United States to export wheat on a protein basis have been unsuccessful. It was recommended that the inquiry should be extended to the principal wheat-importing countries of Europe.

The Committee on Agriculture and Colonization of the House of Commons, after giving consideration to the above-mentioned Interim Report, recommended that the proposed European inquiry should be proceeded with. This request was referred to the National Research Council, and duly carried out in the fall of 1929.

Visits were paid to grain exchanges, grain merchants, millers, and bakers, in various countries. The writer wishes to acknowledge gratefully the cordial welcome and assistance which he received from all individuals and institutions visited. He is especially indebted to the Canadian Government Trade Commissioners, to the representatives of the Canadian Wheat Pool, and to Mr. George I. S. Broomhall and his staff in Liverpool and London.

RELATION OF PROTEIN TO BAKING STRENGTH

In the Interim Report, it was stated that protein content could be accepted as the nearest approach to an ideal index of baking strength available, when baking strength was defined as the ability to produce a large well-piled loaf of good texture. The reservation made then in regard to the absence of conclusive statistical proof of this relationship may now be withdrawn. During the past year evidence has accumulated rapidly that the irregular results in regard to this point often obtained in baking tests have been due mainly to deficient gas production in the dough preventing the loaves attaining the maximum volume which the protein was capable of supporting. The use of " differential " baking tests, in which are added various stimulants to gas production, has brought out much more clearly the relation between protein content and loaf volume. The blend baking formula used as a differential test in one of the laboratories co-operating with the National Research Council, in which 40 parts of White Club wheat flour (weak) are added to 60 parts of the test flour, has also shown that protein content is closely related to reserve baking strength.

It should be noted that loaf volume is not accorded by European milling chemists nearly as much importance as is usually attributed to it in America. In the United Kingdom, the market demands a loaf of only moderate size, with fine pores and mellow texture. Bread made from straight Manitoba flour does not suit the public taste as well as bread made from blended flours. The production of a flour with the capacity for making large loaves cannot therefore be regarded as an end in itself, but this property in flour is nevertheless justly regarded by Canadian chemists as an indication that it possesses the necessary reserve strength which will give the desired " lift " to blends of weaker flours. Further justification of the emphasis placed by Canadian chemists on loaf volume is found in the fact that almost invariably the largest loaves in any test batch are the best in all other characters as well.

It should be noted also that the proposal to utilize protein content as a factor in grading was restricted to wheat of the contract grades, Nos. 1, 2, and 3 Manioba Northern, and it is only to wheat of these grades that the foregoing remarks in regard to the relation between protein content, loaf volume and blending value can be held to apply strictly. The regulations governing these grades specify that the wheat shall be well-ripened and sound, and that the varieties admitted to these grades shall be of good milling quality. This is of special importance, since one of the most universal objections met with in Europe to the use of protein content as a factor in merchandizing wheat was that a chemical test of protein tells only the *quantity* present and gives no information as to the *quality*.

Such an objection is readily understood, when one considers the wide range of wheat types which the European miller is accustomed to handling. Wheats of widely different types may also vary so widely in protein quality that a mere statement of quantity has little significance in regard to baking strength. It is perhaps largely on account of such experience that European millers on the whole take very little stock in chemical tests, but pin their faith rather to physical tests of quality. Even for the purpose of determining the quantity of protein, they prefer the " washed gluten " test to the chemical test. In the former test, the starch and soluble material are washed out of a sample of dough kneaded under a stream of water. The weight of the residual mass of gluten gives the necessary information in regard to quantity, and a skilled operator can also form a fair estimate of the quality by the handling properties of the wet gluten, and by the form, wrinkling and colour which it assumes on drying.

It was found difficult to persuade even some of the cereal chemists met in Europe that when only sound wheat of a single class is in question, as in the Manitoba contract grades, the grades themselves are a guarantee of at least fair quality in the gluten, and that baking strength and blending value will be roughly proportional to the quantity of gluten present. Of course, cereal chemists recognize that even in the same wheat variety the gluten quality varies to some extent with conditions of growth, and the exact extent of this variation has never been determined because exact methods for the measurement of quality are lacking. Nevertheless, cases in which the gluten of sound, well-ripened Marquis wheat (the standard type of the Manitoba grades) has not been of at least fair quality must be very rare, if indeed any such case has ever been observed. Red Fife wheat (the predecessor of Marquis in the Manitoba grades) has been grown in various parts of England for 21 years without any loss in quality.[1] On the other hand, variations in quantity of gluten in all varieties are very wide, and this, of course, is the justification for the proposal to introduce protein-testing.

As pointed out in the Interim Report, it is necessary to guard carefully against extending any generalization in regard to a relation between protein content and baking strength, to unsound wheat. Immaturity, sprouting, frost and heat injury are all associated with a lowered protein quality. It is for this reason that the proposal has been limited to wheat of the contract grades, into which only essentially sound wheat is admitted.

Some European chemists, however, show a full appreciation of the significance of protein as an index of the value of wheat for blending purposes. The following quotation from a paper by an English cereal chemist[2] expresses this point of view. Referring to the tendency of unsoundness to reduce the weight per bushel, he says:—

".. ..When the protein figure is high and the natural weight abnormally low, the sample must be regarded with suspicion in judging its quality from the protein figure. But

[1] Humphries. A. E., and Hutchinson, Robt. Report on the quality of Red Fife wheat. Nat. Assoc. Brit. and Irish Millers, London, 1923.

[2] Hay, J. Gordon, F.I.C. The significance of protein. The interpretation of many thousands of tests. Milling, 71:344-345. Sept. 29, 1928.

when the protein content of a hard wheat is high and the natural weight normal for that season's crop, such a wheat will undoubtedly give a much stronger flour than one with a similar natural weight, but lower protein figure".

Later he adds that:—

"With the exception of Plate wheats....it may generally be taken that with sound wheat, approximating to the normal natural weight for that season's crop, the protein content intelligently interpreted is the most valuable, simple, single and rapid test which can be applied to indicate the strength of a sample. Further it is particularly applicable to hard wheats, which are the ones which are bought for strength.

"It is of course understood that these protein figures can only be compared with figures for the same class of wheat; thus a No. 2 Manitoba natural weight 64 and protein 13 per cent is much stronger than a No. 2 Manitoba of the same natural weight and protein 12 per cent, but this latter cannot possibly be compared in strength with an Australian and a Durum, both of the same natural weight and protein content, any more than one could expect the same milling yield from these different classes of wheat of the same natural weight. Such wheats, owing to the very different physical properties of their gluten, would naturally give entirely different baking results, just as their physical differences cause them to give a different yield of flour".

SURVEY OF EUROPEAN COUNTRIES

England

In spite of the fact that most Canadian cereal chemists and some English chemists are convinced of the importance of the protein content of sound wheat within a given class, as an index of baking strength and blending value, most English millers either do not accept this view or do not feel it practicable to act upon it. While innate conservatism undoubtedly plays a part in determining the resistance both of English and of other European millers towards a change in the method of buying their wheat, there are nevertheless other good reasons why they oppose the singling out of protein as a key factor in the merchandizing of Canadian wheat.

English millers are used to thinking in terms of a large number of widely different classes of wheat from which they must select the components of their blend in suitable proportions, having regard to the special properties and relative prices of the different classes, and the characteristics desired in the flour product. Protein content is to them only one factor out of several important ones which they must consider. To quote from a report of the Director of Research, Research Association of British Flour Millers:[3]

". . . Blending is not merely a means of adjusting length of fermentation, fermentation tolerance, dough toughness and stability; but all other flour, dough and loaf characters must be so adjusted that the resulting flour blend is of invariable quality and this in spite of the fact that wheats have individual peculiarities so that it is not always possible to place them in their proper positions in a fixed scale of characters. Durum and Indian wheats, for example, are so peculiar in many respects that they cannot strictly be compared with other wheats, but are in separate classes by themselves; yet they have to find a place somewhere in the British miller's grist. Again English, Red Winter, Durum and Rosafe Plate wheats favourably affect loaf flavour; English, White Pacifics, Plate and Australian are noted for whiteness, the last named parcticularly for its bloom; Rosafe, Australian, Duluth, and Durum wheats produce soft and silky crumb texture. Is it any wonder that the British miller, doubtless through sheer necessity excels all other millers in his skill in blending and conditioning wheat?"

It will be clear from the foregoing quotation that different wheats coming on the British market are valued for quite different properties which they contribute to the blend. For example, "bloom" is scarcely less important than strength, and soft Australian wheats are often at a premium because of their

[3] Fisher, E. A., M.A., D.Sc. Flour quality. The Nat. Joint Industrial Council for the Flour-Milling Industry, London, 1929.

superiority in this quality. Figures presented on page 49 of the Interim Report show the average price of Australian wheat (which is not divided into grades) to be slightly above that of No. 3 Manitoba, and similar data are given in a recent British report.[4] Reasons for the higher price of Australian wheat include not only the "bloom", but also the lower moisture content (which was stated by millers to be equivalent to an average difference in value of two shillings per quarter) and higher flour yield. Supply and demand work in the usual way in regard to the prices of the different kinds of wheat required in the blends.

No attempt is made by English millers to turn out a flour of standard chemical composition, as is done in American mills, but the aim is to produce a flour of constant baking properties. On account of the variability in proportions, composition and properties of the components entering into the wheat mixture, the protein content of the flour may vary widely without corresponding variations in its baking behaviour.

Manitobas (to use the current European abbreviation for the Manitoba Northern grades) are valued for the "lift" and "fermentation tolerance" which they confer on the blend, properties which are both associated with protein content. When relative prices warrant it, British millers like to use about 40 per cent Manitobas in their mixture. Occasionally the proportion may be increased to 45 per cent, but this is about the maximum which can be used without making the flour unsuitable for baking by ordinary English methods. With larger percentages the dough becomes too tough and stable, failing to ripen properly in the usual fermentation time.

These restricted proportions of Canadian wheat in English blends represent a great change from conditions which obtained some years ago, when London millers used from 80 to 90 per cent Manitobas and 10 to 20 per cent domestic wheat. Within the last few years one London firm, when hard put to it for other suitable wheats, tried to work in 70 per cent Manitobas, but the bakers would not accept the flour. Again, one of the largest London baking firms not long since sought to popularize their bread by mixing in a higher proportion of Canadian flour, thus making a larger loaf. But they got complaints that the crust was tough and leathery: their customers preferred a mellower loaf and did not seem to care about it being smaller.

The decline in the proportion of Canadian wheat in English blends was most pronounced in the fall of 1929, because of the lower prices of competing classes. Firms which had been using up to 45 per cent in the summer dropped to 20 per cent or even less, some actually getting along with none at all. They were enabled to do this because of the unusually large volume and high quality of the Plate crop. Some firms used up to 60 per cent Plate in their mixtures. Bahia Blanca, the best class of Plate wheat, was stated by some millers to be this year practically equal in quality to Manitobas. Normally, American Hard Winter is the chief competitor of Canadian wheat. The former is not far behind Manitobas in strength, and makes up for its slight inferiority in this respect by giving a little better colour and extraction. It is significant that attempts made a few years ago to work up an English trade for high-protein Hard Winters failed of success because no takers could be found who would pay worthwhile premiums.

Changes in methods of baking are partly responsible for the declining percentages of Manitobas in English blends. The growing use of panned bread, in which the sides of the loaves are supported, has made strength less imperative. The advent of the eight-hour day has hastened a trend towards shorter fermentation processes, in which less strain is put upon the stability of the dough; in which, in fact, weaker flours must be used, since doughs made from strong flours

[4] Report on the marketing of wheat, barley and oats in England and Wales, Table IV. p. 182. Ministry of Agriculture and Fisheries, Economic Series, No. 18, 1928.

would not have time to ripen properly and would give poor loaf volume. High-speed electric mixers, which in American baking practice break down the physical structure of tough doughs made from strong flours, are practically unknown in Europe. The mixers in common use for the most part simulate the gentle kneading action of the human hand.

Small bakers, who still turn out the major portion of the bread used in the country, are realizing the economic advantage of a shorter fermentation process, which not only simplifies the labour problem, but also makes it possible to use a weaker blend of flour, usually cheaper than a stronger blend or than straight Manitoba flour. Undoubtedly the relatively high prices of Manitobas in the fall of 1929 was the direct cause of the further drastic reductions in the proportion used, and this in turn was widely stated to have accelerated the trend towards shorter fermentation processes of baking.

There is some evidence, however, that English millers, with all their skill in blending, were not able to make such drastic reductions in the quantities of Manitobas used, without some deterioration in the quality of the flour and bread produced. Complaints of the flour were made by bakers, and of the bread by various individuals. Some of the complaints in regard to the bread, however, may have arisen indirectly from the strict enforcement of loaf-weight regulations. Prosecutions for slightly under-weight loaves have caused bakers to be inclined to undercook their bread rather than run a danger of drying it out too much. This leads sometimes to soggy, unpalatable bread.

A Canadian demonstration bakery in London, to distribute bread made from Manitoba flour as advertising propaganda, has been proposed from time to time in various quarters. It was impossible to get any unanimity of opinion as to the possible value of such an undertaking. Some thought it an excellent idea, while others were dubious. One prominent miller stated that when he came to London twenty-six years ago, he milled straight Manitoba flour and captured the pick of the West End trade. He thought, however, that this trade could not be revived under the altered conditions. It has already been pointed out that English millers like to use 40 to 45 per cent Manitobas when they can do so economically, but that occasional recent attempts to increase these proportions substantially have not met with favour from the consumers. It is of course to be remembered that the limitation, apart from economic considerations, is largely prescribed by English baking methods. The introduction of Canadian baking methods would make it possible to use stronger flour satisfactorily, but the stronger flour would likely cost more, and whether the superior attractiveness of the resulting bread would be great enough to induce any large number of people to pay perhaps a halfpenny per loaf more for it may be open to question. Undoubtedly some people would, in fact a prominent individual was met on the London Corn Exchange who for a considerable time had bought his bread at a higher price from a baker who baked by hand with Manitoba flour. If the popular taste demanded such bread, regardless of slightly greater cost, it would justify millers in continuing to use at least a substantial percentage of Canadian wheat even under such conditions as obtained last fall. While it may be questioned that a single demonstration bakery could have much influence on public taste, the idea behind the proposal is a good one, and worthy of consideration.

The diminishing use of Canadian wheat in England makes the time particularly inauspicious for launching a scheme of marketing this wheat by protein content. In a number of quarters it was suggested that a knowledge of the protein content of Canadian wheat would be of only restricted significance to the miller unless he knew also that of the wheats with which it was to be blended; that a variation in the protein content of a single component may have comparatively little effect on the average protein content of the mixture, particularly if that component is used in limited proportions. This objection however seems beside the point, which is that Canadian wheat is used for the

strength it adds to a mixture, and its value for this purpose varies with its protein content. Moreover, most of the large millers make gluten tests of all the wheat they use, and at least one consulting chemist, who advises about sixty small millers, calculates the amount of protein contributed to the mixture by each component. But it is to be expected that interest in a proposal touching the grading of a commodity should wax and wane with the volume of trade in that commodity.

A moderately high protein content is generally regarded even in England as a factor of safety, or, as it is more commonly stated, it is considered unsafe to allow the protein content to fall below a certain minimum. Consequently, they are interested in knowing the protein content of the wheats they use, but are not necessarily concerned that it should be high. One well-known miller at the date of interview had just found it necessary to reduce the protein content of his mixture in order to get the desired properties in his flour. For some purposes and with some mixtures, 8 per cent of protein in the flour is sufficient, though more frequently English flours fall between 9 and 11 per cent.

While, therefore, most English millers thought a notation of the protein content on Canadian grade certificates would be interesting additional information, very few indeed thought there was any likelihood of price discrimination between lots of different protein content, unless the difference was extremely wide. One buyer stated that he would not discriminate in the price of two lots unless the difference in protein content amounted to 2 per cent or over. They are much more concerned in securing constancy of grade qualities than in having opportunity to bid premiums for superiority in protein content or any other single factor. Their problem of blending so many different kinds of wheat is already complex, and they are opposed to adding further complications by having the same grade mean different things, as it would if subdivided by protein content. Even the idea of having protein content a factor in the definitions of the grades, and consequently a minimum content guaranteed, while it did not introduce any complications from their point of view and so did not provoke opposition, still failed to excite active practical interest.

After discussion with various individuals connected with the National Association of British and Irish Millers, the following three questions were formally placed before that body:—

(1) Would U.K. millers welcome a revision of Canadian wheat grading methods to include either: (*a*) a guaranteed protein content in the contract grades Nos. 1, 2 and 3 Northern; or, (*b*) a notation of the protein content on the grade certificate accompanying each lot? (The latter alternative assumes that means can be devised for maintaining the identity of lots after making the protein test.)

(2) If Canadian wheat of the contract grades Nos. 1, 2 and 3 Northern were sold on a guaranteed protein content, would U.K. millers be sufficiently interested in such protein content to offer premiums for lots which were above the guarantee (as well as demand discounts for lots which were below)?

(3) Is there any other way in which U.K. millers would like to see protein content made a factor in the merchandizing of Canadian wheat?

These questions were duly considered by the Flour and Wheat Feed Committee of the Association, and the following general reply given:—

"This Committee recognizes that Canadian wheat realizes relatively high prices because of its characteristic inherent qualities, but in their opinion a guarantee of protein content in standard grades would present difficulties without compensating advantages."

Trade Complications.—Grain merchants as well as millers are opposed to the introduction of protein testing because of the complications it would add to the trade. The first difficulty pointed out is that under the present system the identity of the wheat is not preserved. Mixing of cargoes of the same grade takes place after the "certificate final" has been issued at the head of the lakes. We may even have two or three Canadian shippers selling to two or three different European buyers, mixing their lots in the same hold. The certificates as received in Europe therefore do not necessarily belong to the lots they purport to represent. It would obviously be necessary to have protein notations on the certificates represent seaboard tests.

Apparently no mixing takes place in European ports, all parcels being stored separately until delivered to millers. The problem of segregating and maintaining the identity of shipments belongs therefore to Canada (and American shipping ports) and need not necessarily concern European buyers, except that the latter must be satisfied that the problem has been solved before they can have confidence in the certificates. Canada and the United States are the only countries with a "certificate final," which gives the buyer no recourse if he is dissatisfied with the wheat as received. Many millers were emphatic that if protein were introduced as a market factor, there must be appeal laboratories on the European side, and scope for adjustment allowed, in the same way as adjustment may now be made, for example, on Australian wheat if below "Fair Average Quality," or Plate wheat if below the standard bushel weight of the season.

A second difficulty is that all wheat in the first instance is bought as futures (about three months ahead), since millers must make advance provision for oikeeping their mills going. Merchants doubted that it would be possible to take account of protein on a rapid futures market, and both millers and merchants thought it questionable that the protein content of future deliveries could be guaranteed. The fact that marketing by protein content had been successfully developed in the United States was not held to be significant in relation to Great Britain. It was pointed out, among other things, that in the United States merchants buy for direct sale to millers, while Canadian wheat is bought by merchants in Canada for sale to other merchants in the United Kingdom.

Small millers on the whole took more interest in the proposal to introduce protein-testing than did the large millers. This was found to be so, notwithstanding the statement of a large buyer, that many small millers do not understand the meaning of protein and take their lead from the large millers, who do understand it but do not want to be bothered with extra complications. The actual interest of the small millers may be partly because they have no laboratories, and feel that a knowledge of the protein content of the wheat would remove one buying handicap they suffer in comparison with the large millers. Again, small millers buy more largely on a sample market, while large concerns buy their wheat mostly before it is shipped from Canada. It is a relatively simple matter to use protein as a factor on a sample market, as compared with the difficulty of insuring the future delivery of wheat of definite protein content. However, less and less wheat is being bought on a sample market, even by the small millers, and more and more without the grain being seen. The latter is commonly bought in transit and redirected to the mills. One difficulty of small millers is that they have not much storage capacity, and must buy from cargoes due to arrive at the right time. This would restrict their opportunity to select lots on the basis of protein content.

Scotland

There are two important differences in milling and baking practices in Scotland, as compared with England: (1) a long fermentation process of baking is still largely used, and this requires strong flour; (2) the millers mill straight wheats for the most part, leaving the bakers to do the blending.

One of the largest milling firms was found, at the time of the inquiry, to be milling three kinds of wheat (in different mills), namely: (1) straight Manitoba, (2) straight Kansas Hard Winters, (3) a blend of 50 per cent Manitobas and other wheats as available. The smaller millers confine themselves almost entirely to straight wheats.

In Glasgow, the "quarter-sponge" method of baking is commonly used, with a fermentation period of about eighteen hours. The dough is mixed in three stages, a quarter of the flour being used in the first sponge, and the remainder added in two later stages. Straight Manitoba or other very strong flour is used at the first stage (which has to withstand the longest period of fermentation), a slightly weaker blend at the second stage, and the weakest blend at the third stage. In Edinburgh, a "half-sponge" method is used, with the flour added in two stages and a fermentation period not longer than twelve hours. Here again the stronger flour is added at the first stage.

The trend even in Scotland is towards shorter fermentation. This was hastened to some extent in the fall of 1929 by the relatively lower prices of wheat other than Manitobas, though the latter still make up the bulk of the wheat used. In a baking competition advertised during the course of this inquiry by the largest system of Scottish bakeries, the whole process from the time of mixing the flour and other ingredients until the loaves were out of the oven occupied only $7\frac{1}{4}$ hours. There was reported to be also a rather strong possibility of legislation against night baking, which would force the general adoption of a half-sponge method and shorter fermentation period. With shorter fermentation, as already pointed out, a weaker blend of flour is used.

Even with the long fermentation method still predominantly used in Glasgow, the largest milling organization gave their considered opinion "that protein could not be used to advantage under present conditions as a factor in purchasing wheat." A group of similar millers interviewed stated that they could not pay a premium for high protein wheat, since they could get no more from the baker, who wants average Manitoba flour. They pointed out also, as did others in all countries, that they would need to know the weight per bushel as well as the protein content, if they were not to be in danger of losing more by lower flour yield than they might gain by the higher protein content of thin lots.

On the whole, all doubted the value of introducing protein as a factor in marketing Canadian wheat, and felt it would be an unnecessary complication. They emphasized the mechanical difficulties of merchandizing, and stated that if protein were used they would not want to be dependent upon a certificate final without an appeal laboratory on their side of the water. Far from desiring segregation by protein content, these millers who mill straight Manitobas were especially emphatic as to the importance of constancy in grade qualities, since they have not the same opportunity to cover up inequalities by skilful blending.

Ireland

Ireland is in the special position of importing practically all the wheat or flour used, only a very small percentage being grown in the country; also of having a number of very distinct requirements in regard to kinds of flour.

Retail shop flour makes up about 60 per cent of all the flour used in the country. This is a weak flour, milled principally from Pacific White wheat, and is used largely for the home-baking of bread with soda and buttermilk rather than with yeast.

In the cities, practically all bread is made by large bakers, who used blended flours and "straight" doughs (all flour mixed at one stage). The time consumed in the entire process from mixing to out-of-oven varies in different cities, from about 3 hours (in Cork) to 7 hours (in Dublin). This type of baking accounts for about two-thirds of the remaining bread of the country (*i.e.*, excluding the soda-buttermilk bread). The straight dough method and relatively short fermentation periods do not demand great strength in the flour. The requirements of the 7-hour process used in Dublin were being met at the time of the inquiry by a milling mixture consisting of 50 per cent Manitobas, 40 per cent Australian, and 10 per cent Plate. The shorter processes in other parts of the country might of course be satisfied with still weaker blends.

About three-quarters of the country bakers use a long sponge fermentation, with straight Manitoba flour for the sponge and weak flour for "backing" (kneading into the spongs) at a later stage. Country baking is done entirely by hand work. There was considerable difference of opinion among those interviewed as to whether the trend of country baking was towards straight doughs and shorter fermentation. A number of bakers had changed in that direction, but some were changing back.

To cover the needs of the foregoing three types of baking, Irish millers therefore turn out three kinds of flour: (1) weak, for soda-buttermilk bread; (2) blend, for city bread; (3) straight Manitoba, for country bakers' sponge. These are given, as already indicated, in the order of relative quantities milled. The two latter kinds of flour normally require Manitoba wheat, though some of the weaker blends for the shorter fermentation methods may under the special conditions which obtained in the fall of 1929 have contained no Manitobas.

No bread is made with straight Manitoba flour. Even the bread made by country bakers has weak flour added to the sponge at the second stage. The average two-pound loaf sold in Canadian cities is fully 30 per cent larger than the two-pound loaf of the Irish cities. The Irish workman insists on close-grained solid bread, as it is his staple food and he wants it to "stay on his stomach." A blend of soft flour is required to make break at once fine-grained and mellow. Canadian bread was described by Irish millers and bakers as "coarse" and "harsh" and "full of wind".

It will be readily understood from the foregoing discussion that Irish millers do not maintain a high protein content in any large proportion of the flour produced in the country. They do however, maintain a minimum protein content in their flour, and think information as to the protein content of the Canadian contract grades would be valuable to them, provided the quality of the protein can be guaranteed by grade specifications. They doubt, however, that there would be special competition for high protein lots, leading to the bidding of any premiums. Usually they have no difficulty in getting all the protein they need.

Norway

In Norway the wheat-milling industry is a state monopoly. The whole country uses strong flour, produced from milling mixtures containing ordinarily 75 per cent Manitobas. Like all other European countries, however, owing to price conditions in the fall of 1929 Norway replaced Manitobas largely by Plate and American Hard Winter wheat.

Officials of the Norwegian State Grain Monopoly were very doubtful that it would be practicable to market wheat by protein content in their country.

They are well satisfied with the present system of grading. Under conditions of no competition, such as theirs, it is better to supply an average quality wheat to all mills. If the grades were sub-divided, or lots of different protein content segregated, all their mill managers would undoubtedly ask for the best sub-grades or parcels, and low-protein parcels would be difficult to dispose of. This organization is therefore against the proposed change in the system of grading.

France

In France, and in other continental countries such as Germany and Italy, the use of Canadian and other foreign wheat is restricted by import duties and sometimes also by regulations setting definite limits to the percentage of imported wheat which may be used in milling mixtures. The latter type of regulation has reached it most extreme stage in France, where, according to a press despatch dated January 2, 1930, the French Government has ordered the use of 97 per cent home-grown wheat in French bread. The large French crop of 1929 was doubtless the factor which led to this severe restriction. At the time of this inquiry, however, French millers were still commonly using 10 to 15 per cent of Manitobas or similar imported hard wheat.

The French wheat crop is of rather poor quality, and some imported wheat must be used to improve its baking strength. Merchants were of the opinion that if wheat could be imported free of duty, French millers could compete on foreign markets in the sale of their flour, and would use more Manitobas to improve its quality. Even under the conditions existing prior to the latest restriction, however, they could afford to use only a little imported wheat, since price rather than flour quality dominated the situation. The prices of flour and bread were fixed by the Government, the price scale for flour varying according to the percentage admixture of Manitobas.

The wheat import duties of European countries are not *ad valorem* duties, but bushelage duties. In France the rate is about 55 cents per bushel, regardless of the quality of the wheat. Naturally this leads to a preference for high-grade wheat, and is perhaps one of the reasons why continental millers on the whole took more interest in the proposal to use protein as a market factor than did British millers.

The general manager of one of the largest milling organizations in France stated that, beginning with the crop of 1928-29, all Manitobas and Hard Winters purchased by his firm had been tested for quality in Winnipeg or New York. Manitobas he buys exclusively for increasing the strength of his milling mixtures, and because of the cost and high bushelage duty is anxious to get the highest possible quality. Under the present system of grading, millers must take a chance on variation in different shipments, and take this into account in the prices offered. The more certainty they had of quality, the higher could they afford to pay. He stated definitely that he would pay according to protein content.

Unfortunately, the foregoing opinion is by no means unanimous among French millers. Even within the same concern, other officials, including the chief chemist, were doubtful of the usefulness of the protein test. They objected that it guarantees only quantity and not quality. This, as we have seen, was a very common objection which, with reference to the contract grades of Manitoba wheat, is not altogether well founded.

Objections in regard to trade complications were also numerous, especially of course among the merchants and brokers. It was pointed out that most of the French trade in Manitobas is in small lots of about 50 tons. Some larger mills may of course place larger orders, running up to a maximum of about 700 tons, but ordinarily a cargo is divided among many buyers. Under a system of

protein grading, these might want a number of different protein contents, and it would obviously be impossible to satisfy them. Again, it would probably be difficult to dispose of low protein lots. When prices are high, the millers live from hand to mouth, they take small lots from week to week, and want them of constant quality. Another difficulty is that, on a falling market, buyers will seize every excuse to refuse contract deliveries. Sales on sample are avoided as much as possible because they so often lead to trouble. Cargoes of Plate wheat, of which the price is subject to adjustment if below the standard bushel weight of the season, are sometimes held up a long time by disputes and arbitration. A guaranteed protein content would lead to the same difficulties.

Summing up the situation found in France, it appears that some of the more scientific millers appreciate the value of protein and would like to see it made a factor in grading Canadian wheat. Other millers are indifferent, or opposed because the protein test guarantees only quantity and not quality. Merchants and brokers are actively opposed because of the added complications to the trade.

Germany

In Germany there was more interest in protein-testing than anywhere else. No doubt the first reason for this is simply the more general application of science to industry which is found in Germany as compared with all other countries. German millers were not content with the idea of stopping at the protein test; they desired to have also the moisture content and the weight per bushel stated on the certificates accompanying each parcel of wheat. This is in fact the way their own wheat is handled; it is not graded, but sold by sample, and the gluten content and other factors of value are taken into account. In the times when Russian wheat was imported, it was bought by sample, and the price varied according to quality.

The German import duty on Manitoba wheat in 1929 was about 49 cents per bushel; for 1930 it has been increased to about 62 cents per bushel. Under the conditions obtaining in the fall of 1929, German millers were using only 5 to 10 per cent Manitobas in their mixtures. As in other countries, they had replaced Manitobas for the time being with Plate and Hard Winters. When prices make it possible, they like to use up to 50 per cent Manitobas. This is the maximum proportion of imported wheat which Government regulations permit.

Cereal chemists in Germany, as elsewhere in Europe, laid more stress on physical than on chemical tests of flour quality, though they made both kinds of tests. Some individuals of course were of the opinion that the difficulties of using the protein test in the merchandising of wheat might be too great, although all considered the protein content of the wheat important. The consensus of opinion was that protein premiums would certainly be paid if the difficulties of the system could be gotten over.

Italy

In Italy, the millers' attitude was more like that encountered in England. Generally they were convinced that a chemical test of protein quantity had little significance unless accompanied by physical tests of quality. It was impossible to persuade them that even in the special case of restricting comparisons to sound well-ripened wheat of a single type, as in the Manitoba Northern grades, protein quantity might of itself be a valuable indication of blending value. There were of course some exceptions to this view. A miller in southern Italy supported the protein-testing proposal warmly. In the south they use low-protein mixtures, and prefer to import mainly soft white wheats (Australian and

Pacific White) for the better colour of the flour, with only a small admixture of very strong, high-protein wheat. This miller would pay a premium for high protein.

In northern Italy, where considerable importance is attached to getting large loaves, the millers desire about 11 per cent protein in their milling mixtures. In southern Italy, where colour is the important factor and loaf volume is at a discount, only about 9 per cent is required. Most of the baking throughout the country is done in small shops, and is not scientifically controlled.

The manager of one large milling concern in the north thought he might buy to advantage on a protein basis, but this opinion did not appear to be widely held. A large grain broker stated that buyers had implicit faith in the grade "Manitoba" and would not inquire further, but buy the cheapest parcels of Manitobas they could get, provided they were of the higher grades. The import duty of about 70 cents per bushel makes it unprofitable to buy the lower Canadian grades.

The large quantity and low price of Plate wheat in 1929 led to its substitution in large measure for Manitobas. Some of the mills had found they could get on entirely without Manitoba wheat, and one miller described its use as "a bad and expensive habit". However, the general opinion was that some of it should be used, in the interest of bread quality. Some small mills with a special trade use up to 40 per cent Manitobas.

PROPOSALS FOR UTILIZING PROTEIN CONTENT

In the Interim Report there was included a rather full discussion (pp. 29-35) of two alternative proposals for making protein content a market factor, in relation to the problems to which they might give rise in Canada. It is appropriate now to re-examine these proposals in the light of conditions and viewpoints found in Europe.

The first of these proposals was to make protein content one of the factors in the definitions of the grades. This amounts merely to fixing a minimum protein content for each grade and at first glance seems the simple straightforward thing to do, particularly since it would involve no new complications in the European end of the trade. On examination, however, there were found to be serious difficulties in putting the scheme into effect in Canada. The greatest difficulty was that buyers at country points could not grade wheat satisfactorily, since they would have neither the time nor the facilities to make protein tests. A second difficulty was that protein content varies more widely from year to year in a given grade than it does from grade to grade in a given year. For example, the average protein content of No. 3 Northern in the 1929-30 crop of Alberta and Saskatchewan respectively is 2·5 and 2·3 per cent higher than in the crop of 1927-28; while the average protein content of Nos. 1, 2 and 3 Northern in these two provinces in 1929-30 is the same in all three grades. The maximum spread between the average protein content of No. 1 and of No. 3 in any province in any given one of the three years for which adequate official records are available is only 1·3 per cent.[5] It would be hard therefore to set protein standards which differentiated the three contract grades, and still harder to establish any single standard which would be satisfactory in different seasons.

The alternative proposal of continuing to grade the wheat much as at present, but adding protein content as a notation on the certificate, was felt to be more workable from the Canadian point of view, and to possess certain advantages over the other. Notably it would make possible the separate con-

[5] Birchard, F. J., and Aitken, T. R. First Report on the protein content of the 1929-30 crop. Dominion Grain Research Laboratory, Winnipeg. October 1, 1929. (Mimeographed).

sideration by the buyer of the two independent factors of value, namely, milling yield as indicated mainly by weight per bushel, and making strength as indicated by protein content. At present the samples entering into Nos. 1, 2 and 3 Northern show in this order a progressively wider range of protein content, those degraded because of leanness (low weight per bushel) being usually high in protein while those degraded because of starchy kernels are usually plump but low in protein.

It was pointed out in the Interim Report, however, that the notation system would complicate merchandizing, by necessitating the segregation of high and low protein wheat. This segregation would have to be carried through to the European market, and it has since been established that it would be objectionable to the majority of European buyers. Only a few (notably in Germany) supported the proposal heartily. Most of those who expressed an interest were careful to point out that a notation on our present certificate final would have no significance, as it is not a seaboard certificate; also that buyers must have the right of appeal to laboratories on their own side of the water. The great majority, however, were strongly opposed to segregation of parcels by protein content, a practice which in effect amounts to subdivision of the grades. Constancy of grade qualities was the most unanimous desire expressed in Europe.

The samples of wheat entering into the contract grades show wide variations, but no such spreads are found in the cargoes leaving the head of the lakes or the seaboard. This will be evident in the following table.[6]

TABLE SHOWING AVERAGES AND SPREADS OF PROTEIN CONTENT OF SURVEY SAMPLES AND CARGOES

—	Crop 1927-28				Crop 1929-30	
	Protein content of survey samples		Protein content of cargoes		Protein content of survey samples	
	Average	maximum spread	Average	maximum spread	Average	maximum spread
	%	%	%	%	%	%
1 Nor.	12·1	5·0	12·4	1·2	13·7	7·9
2 Nor.	11·6	5·0	11·8	1·4	13·5	9·9
3 Nor.	11·5	5·5	11·3	1·8	13·6	11·6

The protein survey figures are averages for the Prairie Provinces for a low-protein year (1927-28) and a high-protein year (1929-30). It will be seen that the spread between the highest and the lowest sample entering a given grade is much greater in the high-protein year. In No. 3 Northern in 1929-30 the maximum spread is almost equal to the average for the grade, the range (not shown in the table) being 7·4 to 19·0 per cent protein.

The cargo figures are based on a large number of cargoes out of Fort William, Montreal, Vancouver, and Prince Rupert. Possibly the spread in 1929-30, when the figures become available, will turn out to be greater than in 1927-28, but in the latter year at least the mixing incident to merchandizing reduced the spread to comparatively narrow limits. Since the figures given in the table show the maximum spread, it will be evident that most of the cargoes fell within a still smaller range.

In view of this small spread in the protein content of cargoes, it is not surprising that British millers have not often found significant variations in the

[6] Survey figures abstracted from report by F. J. Birchard and T. R. Aitken (loc. cit.) and cargo figures from communication from F. J. Birchard.

strength of different lots of the same grade, a statement which a number of them made in explaining their lack of interest in the proposal to add a protein notation to the grade certificate. If cargoes did in fact show a variation in protein content comparable to that found in the original lots of wheat which went to make them up, there is little doubt that British buyers would take an active interest in protein notations. But whether it would be worth while to try to stimulate such interest by deliberately segregating lots of different protein content, in the face of such general hostility to any subdivision of the grades, must be a matter of grave doubt.

If such an experiment were to be undertaken, it may be suggested that the most feasible plan would be to divide the grades into three sub-grades, of low, medium, and high protein content respectively. This would make it practicable to set in the grade specifications protein standards wide enough to cover most seasons satisfactorily. The proportions of the crop entering the three sub-grades would of course vary widely from season to season. If, for example, we selected as limits for these sub-grades in all contract grades: under 11 per cent, 11 to 14 per cent, and over 14 per cent, respectively, the distribution of the crop in the present high-protein season would be roughly in the proportions 10:46:44. In a low-protein season like 1927-28, the order would have been approximately reversed, only a very small percentage of the crop qualifying for the high-protein sub-grade. Under such a system, lots of extra high protein content might command a premium for the purpose of bringing lower lots up to higher sub-grades. The system, of course, would involve the evils of multiplying the numbers of grades and increasing elevator storage problems. It must also be remembered that such efforts as have already been made to work up a trade in high-protein lots of Hard Winters failed of success for lack of takers.

It remains to examine what possibilities there may be of utilizing protein content as a grading or marketing factor in Canada and still export a constant average quality of wheat of each grade.

The establishment of a minimum protein content for each grade would not involve any complications from the point of view of the European merchant or miller, and was in fact suggested by a number of them as an additional check on the constancy of the grades. Unfortunately it would be hard to put into practice in Canada. The chief difficulties have been pointed out above, at the beginning of the present section of this report.

It is incontrovertible that protein content is one of the important factors of value in Canadian wheat, and figures have been presented above which show that the protein content of parcels contributed by different growers to the composite found in a cargo may vary widely in this respect. The problem is then to find a way of evaluating the individual grower's wheat, which takes account of protein content. Since this cannot be done by buyers at country points, it would appear necessary to segregate individual lots until the wheat has reached a point where a protein test can be made. If a constant grade quality is to be exported, segregation must cease at the terminal elevators, lots of various protein contents, within a given grade, being there mixed to the specified protein content of the grade. The superior value of high-protein lots must be realized, if at all, by their use in bringing low-protein lots up to grade.

A slight modification of this scheme, which might be more workable, would be to specify a *normal,* rather than a minimum, protein content for each grade. Grading could then be done as at present, except that composite samples of each grower's deliveries would be taken, as in the practice of the Kansas Wheat Pool. Price adjustments could later be made for variations in protein content from the normal. Since most cargoes contain very nearly the same

protein content, these adjustments would be largely confined to Canada. In those cases in which it was necessary, however, price adjustments could be made in Europe in the same way as they are now made for the weight per bushel of Plate wheat and the purity of American flax. This scheme would appear to avoid the necessity of segregating or maintaining the identity of lots, since whatever the value of protein might be, each lot would contribute to or detract from that value in proportion to its bulk and protein content.

The most serious objection to both of these schemes for making protein content a factor in the definitions of the grades is that, with nearly all wheat reaching the export market in a mixture of approximately equalized protein content, there would be no practical basis on which to establish protein premiums and discounts. The only recourse would be for the Canadian Government or the Canadian Grain Trade to set an arbitrary scale of price adjustments to Canadian growers, a procedure so artificial that it could scarcely hope for popular support. It would be a matter of great difficulty to arrive at a logical scale of values, as the absolute value of protein on a world market would vary from season to season with the general quality of the world crop, and there must also be considered the off-setting value of weight per bushel and flour yield, low-protein lots being commonly superior in the latter respect.

With the export market demanding constant quality in the grades, and no subdivision or segregation, it appears that the problem of distributing the sale price of Canada's wheat among our growers in the fairest possible manner, having regard to the real value of their individual lots, is a domestic Canadian problem in the solution of which we cannot at present obtain much help from foreign buyers. A scientific method of grading should certainly take some account of protein content, and should also give due weight to other factors of value, notably weight per bushel and moisture content, neither of which are adequately considered at present. It must be concluded, however, that such a costly experiment as the immediate establishment of a general system of protein testing could scarcely be justified in the absence of more definite prospects of practical support from our chief markets.

OTHER PROPOSALS FOR IMPROVEMENT OF GRADING

Constancy of grade qualities seems to be the outstanding requirement of the European trade. The chief complaints encountered had reference to shipments which dropped close to the minimum of the grades, particularly with reference to weight per bushel and percentage of hard red kernels. " They were within the law," said the manager of one large concern, " but the law ought to be changed." He went on to point out that " fours " were often better than " threes " for this purpose, because of a higher content of dark hard kernels in the former. This was particularly true of the crop of 1918-29.

In regard to weight per bushel, there seemed to be some confusion as to the relative significance of the minimum weights specified for Canadian and United States grades. The Imperial bushel is the volume basis of the Canadian weights, and this is appreciably larger than the Winchester bushel used in the United States, the former being 1·032 times the size of the latter. The corresponding relationship of the minimum weights per bushel of the hard spring wheat grades is shown in the following table. When the Canadian and American weights are thus calculated to the same basis, they are seen to be substantially alike.

TABLE SHOWING RELATION OF MINIMUM WEIGHTS PER BUSHEL OF HARD SPRING WHEAT GRADES IN CANADA AND THE UNITED STATES

Grade	Minimum weghts on basis of Imperial bushel		Minimum weights on basis of Winchester bushel	
	Canada	United States	Canada	United States
	lbs.	lbs.	lbs.	lbs.
No. 1	60	59·9	58·1	58
No. 2	58	58·8	56·2	57
No. 3	57	56·8	55·2	55

The minimum weight per bushel specified for Canadian wheat seems too low in comparison with the high average weight of the crop, until it is remembered that our grade specifications are laid down on the assumption that wheat leaving the terminal elevators will represent an average rather than a minimum of the grade qualities. Since the out-turn should represent a composite of many lots ranging in quality from the minimum to the maximum of the grade, such a result should follow naturally. Artificial factors have in the past interfered with this course of events, sometimes to the extent of causing serious disappointment among buyers. The recent amendments to the Canada Grain Act, prohibiting the mixing of different grades of wheat of the contract grades, and providing that for all wheat grades there shall be set up composite standard out-turn samples consisting of 75 per cent of the average and 25 per cent of the minimum quality of the grades at the primary inspection points, should go far to remove causes of complaint, in regard both to weight per bushel and to percentage of dark hard kernels.

Another rather general complaint was that the quality of the grades deteriorated towards the end of the season. One mill manager produced records of his laboratory tests for the past two years, showing the "quality factor" of No. 4 wheat dropping 10 to 15 per cent towards the end of August or in September. Presumably this is the period during which elevators are being cleaned out in preparation for the new crop, and when miscellaneous lots held back because less marketable must be disposed of. This complaint suggests the need for especially rigorous out-turn inspection at this time of the year.

The "Eastern Certificate" was another common subject of complaint. It appeared to have caused particular dissatisfaction in Italy, where it was stated to be totally unreliable in regard to American Amber Durum. One miller asked especially to have this matter brought to the attention of the Canadian Government. All European millers were emphatic that American wheat should not be allowed to move under Canadian grades.

A suggestion made quite generally by European millers, in view of reports which had reached them as to the increasing use of new varieties in Canada, was that dissimilar varieties should be graded and shipped separately and not mixed with the standard Manitoba grades. European mills have much more elaborate equipment for conditioning wheat than is commonly found in Canadian or American mills. In the larger mills a number of different lots of wheat may be conditioned simultaneously, the treatment accorded different lots being varied to suit their individual physical characteristics. They are thus able to use to good advantage widely different kinds of wheat, provided they can treat them separately before making up their milling mixtures. When wheats of dissimilar physical properties arrive in a mixed condition, however, they are not able to use them to best advantage.

Another suggestion received quite frequently was that more information in regard to the basis of grading should appear on the certificate. Nearly always when the question was raised as to the possible utility of a protein notation on the certificate, the miller would point out the equal importance of information as to weight per bushel and moisture content.

On the whole, however, European merchants and millers are well satisfied with the Canadian system of grading and the way in which it is carried out. Complaints were relatively few; the only important ones have been pointed out above, and these are in a way to be cured. Many persons interviewed stated openly that the Canadian grade certificates were more reliable than any others with which they had to deal.

This attitude is cause for satisfaction to Canada, and also for guarding carefully the integrity of the grade standards. A number of the older millers were inclined to say that the quality of Manitoba, while still high, was "not what it used to be." They blamed the deterioration on soil exhaustion and the introduction of inferior varieties. Fortunately both of these factors are to a large degree controllable. The importance of controlling them is not open to question. With the changing conditions outlined in this report, more than ever must Canadian wheat depend upon high quality to maintain its unique place in a highly competitive market.